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Effect of incorporation of potassium bromate in commercial wheat flour on the proximate composition, storage stability and consumer acceptability of bread

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ABSTRACT: The effect of incorporation of potassium bromate ($KBrO_3$) in commercial wheat flour on the nutritive value, consumer acceptability and storage stability of bread was investigated. The presence of this chemical at various concentrations of 0.8g/kg, 0.16g/kg and 0.32g/kg had no significant effect on the nutritive value of the flour or the baked product. It could also not improve its storage stability which was better controlled by the storage temperature. However, the baked products from flours with the potassium bromate had improved loaf size, crust colour, crust texture and aroma, and were preferred by consumers.

Key Words: Baked bread; Wheat flour; Potassium bromate; Nutritive evaluation; Consumer acceptability.

Introduction

Wheat (*Triticum vulgare*) is perhaps the most popular cereal grain for the production of bread, cakes and other pasteries. It produces white flour with a unique type of protein that can give bread dough with the strength and elasticity required for low density bread with desirable texture and flavour (Ihekoroye and Ngoddy, 1985).

The use of various forms of food additives have been employed in flour milling industries. Several reports have pointed to flour improvers such as important food additives. They are employed to enhance the nutritive value and desirability of the flour and consequently the quality of the baked foods. They range from vitamins to bleaching and maturing agents. Amongst them are potassium bromate, chlorine dioxide, ascorbic acid and benzyl peroxide (Ranum et al., 1981). Oxidizing improvers such as potassium bromate and ascorbic acid are frequently used in the flour milling industries to strengthen the flour for baking of a large 'bold' loaf and improve the colour. Kent-Jones and Amos (1967) reported that bleaching and other treatments of flour have been carried out since the beginning of the twentieth century and these agents were used to overcome various problems in the milling industries.

Awan and Okaka (1985) described a chemical additive to a food commodity as a substance or a mixture of substances other than those contributed by the basic foodstuffs, which is added intentionally during any aspect of production, processing or storage, to improve or enhance the qualities of the foodstuff. These include substances that may increase the shelf life of the product, improve colour, flavour, appearance, taste and nutritive value.

Kent-Jones and Amos (1967) emphasized the importance of potassium bromate as a widely used flour improver. The actual amount to bring about improvement in the dough behaviour and in loaf volume is likely to be in the region of 0.15 - 0.25 g/kg depending on the type of flour. This substance is usually diluted with materials such as magnesium carbonate or calcium sulphate to attain 0.20 g/kg concentration in the flour. This is necessitated by the controversy that surround the use of bromate in some parts of the world. The bromate improves the physical state of the dough and results in the production of a better loaf volume than would have been possible if the same flour had been used in the untreated state unless extensive, inconvenient and prolonged storage had taken place (Daniel, 1974). Bleaching and treatment with chemical improvers were carried out in the early days primarily for colour improvement and artificial ageing (Bennion, 1967).

The nutritive value of bread has been widely studied. Brownsell et al. (1989) reported that white bread contains a significant amount of protein (31.24%) compared to other high carbohydrate foods. The fat content is not significant. The high carbohydrate content makes it highly susceptible to microbial growth, especially in humid areas. The problem of storage and spoilage of bread and other baked goods has received considerable attention from food technologists and cereal scientists. The main problems include staling and mouldy growth (Piesookbunterng et al., 1983a).

The aim of the present study is to establish the levels at which potassium bromate could be added to commercial wheat flour to bring about desirable quality, shelf stability and consumer acceptability of bread baked from it.

Materials and Methods

Collection of samples

Wheat grains (*Triticum vulgare*) were collected from the ship at the docksite (Apapa). Samples were collected randomly from four different hatches of jute bags.

Preparation of flour samples

Wheat grains were cleaned and other grains with unwanted materials carefully separated in the labofix cleaning equipment according to AACC (1975). Four kilograms of cleaned wheat grains were tempered at 15% moisture content for a period of 12 hours. Tempering was carried out by adding 35.3 ml of water to 1 kg of wheat grains with intermittent shaking. The grains were milled with the Buhler small scale milling machine in the laboratory to obtain pure-white flour of commercial grade (AACC, 1975; Miller et al., 1979).

Treatment of wheat flour

One kilogram of the flour samples was weighed into different plastic containers which had previously been cleaned and dried. Into each of the weighed flour samples was added 0.08g, 0.16g and 0.32g of potassium bromate ($KBrO_3$) salt, respectively. The fourth sample was not treated with $KBrO_3$ and it served as the control sample. The treated samples were then blended one after the other in a laboratory mill Tovin-Shell dry blender for 15 minutes each. The flour samples were not treated with any other additives or flour improvers.

Proximate analysis of the flour samples

(i) Moisture content:

This was determined according to the method of AACC (1975).

(ii) Protein content:

The protein content was determined by the Kjeldahl method.

(iii) Fat content:

This was determined using the Foss-let electric fat extraction model 15300 according to the method of AACC (1975).

(iv) Carbohydrate content

Carbohydrate was determined by difference (Ihekoronye and Ngoddy, 1985).

(v) Determination of maltose content/10g of flour sample (AACC, 1975).

Ten grams of the flour samples was weighed into a 250 ml conical flask and 46 ml of phosphate buffer was added. The mixture was incubated in a water bath at 30^{o}C for 1 hour with continuous shaking for 15 minutes to ensure uniform diastatic activity. After incubation, 2 ml each of 12% w/v sodium tungstate and 10% v/v of sulphuric acid (H_2SO_4), respectively, was added to the mixture which was then filtered. Five millilitres of the filtrate was pipetted into a sterile 250 ml conical flask and 10 ml of potassium ferricyanide solution added. The mixture was distilled in a boiling water bath for 20 min. The samples were removed and cooled. To this was added 25 ml glacial acetic acid and 2 ml of starch iodide indicator. The mixture was titrated against 0.1N sodium thiosulphate solution and the results expressed as maltose/10g of flour.

(vi) Estimation of the KBrO3 content (in ppm) in the flour samples (AACC, 1975)

Fifty grams of flour was weighed into a 500 ml conical flask and 150 ml distilled water added. Fifty millilitres of $ZnSO_4$ and 50 ml of 0.18N NaOH added to the contents of the flask and shaken for 15 minutes, using a wrist-action shaker. The mixture was allowed to sediment and the supernatant filtered. To 50 ml of the filtrate was added 2 ml of starch solution and potassium iodide indicator. The resultant mixture was titrated against 0.001N sodoim thiosulphate. The solution turned colourless at the end point and the results were expressed as parts per million (ppm) per 40g of flour.

Baking of treated and untreated flour samples (Recipe and Method)

Baking was carried out on each sample of flour treated with $KBrO_3$ and the control. The straight dough method used in commercial baking described by Ihekoronye and Ngoddy (1985) was adapted. The recipe consisted of flour, 200g; butter, 40g; sugar, 160g; salt, 26g; yeast, 10g and water 102 ml. All ingredients were mixed and a dough of uniform consistency was obtained after 5 min. The dough was removed and placed in a fermentation chamber for 2½ hours after which it was removed and mixed for another 5 min. The dought was then cut into desired weights, moulded and put into already greased baking tins. The moulded dough was returned into the fermentation chamber for a period of 3½ hours after which it was removed, placed in the oven at 250^{o}C and baked for 18 minutes.

Proximate composition of the baked products

Bread samples were sliced with a knife and samples crushed using a mortar and pestle. Proximate analysis was carried out on the crushed samples.

Sensory evaluation and acceptability studies

The baked products were evaluated for sensory quality including acceptability by he methods of ranking described by Ihekoronye and Ngoddy (1985) where 1 indicates the best quality and 4 represents the lowest quality. Samples were coded and presented to a consumer panel of eight persons. the attributes evaluated were loaf size, crust colour, crumb texture and aroma. The results obtained from each quality attribute evaluated were subjected to analysis of variance and the differences among the samples were tested at 5% level of significance.

Effects of storage temperature on estimation of consumer acceptability

Bread samples baked from the treated flours and the untreated (control) flour were divided into three groups. All samples were packaged in water-resistant, transparent polythene bags and tightly sealed and stored at 31^{o}C (ambient temperature), 5^{o}C (refrigeration) and –18^{o}C (freezing temperature) respectively for a period of two weeks. Stored samples were monitored and observed for physical qualities, loaf size, crust colour, crumb and crust texture as well as aroma (Edwards and Bamiro, 1977).

Results

Proximate composition of wheat grains and the two types of flour samples

There was a slight increase in the moisture content of the flour samples (mean value = 13.54 ± 0.07%) when compared with that of the wheat grains (mean value = 12.05 ± 0.09%) from which they were prepared. However, there was a slight decrease in the crude protein, ash and carbohydrate content, but there was no significant difference in the fat and sugar (as maltose) contents (Tables 1 - 3). The concentration of the potassium bromate used in the treated flour samples had no effect on the proximate concentration of the flour samples.

Table 1 Proximate composition of wheat grains (*T. vulgare*)

Analytical Parameters	Proximate composition (%) of samples				
	1	2	3	4	Mean ± S.D.
Moisture	11.98	11.97	12.07	12.16	12.05 ± 0.09
Crude protein	12.54	12.50	12.50	12.52	12.52 ± 0.02
Fat	1.60	1.60	1.60	1.60	1.60 ± 0.00
Ash	1.39	1.45	1.41	1.45	1.43 ± 0.03
Carbohydrate (by difference)	75.44	75.33	75.21	75.14	75.28 ± 0.13

Table 2 Proximate composition of treated and untreated flour samples.

Analytical Parameters	Potassium bromate ($KBrO_3$)				
	0 (Control)	0.08 g/kg	0.16 g/kg	0.32 g/kg	Mean ± S.D.
Moisture	13.64 ± 0.07	13.53 ± 0.014	13.50 ± 0.00	13.48 ± 0.40	13.54 ± 0.07
Crude protein	11.14 ± 0.014	11.44 ± 0.07	11.51 ± 0.07	11.52 ± 0.00	11.40 ± 0.18
Fat	0.50 ± 0.00	0.52 ± 0.00	0.52 ± 0.07	0.55 ± 0.00	0.52 ± 0.02
Ash	1.18 ± 0.04	1.18 ± 0.04	1.18 ± 0.04	1.18 ± 0.04	1.18 ± 0.00
Carbohydrate (by difference)	73.54 ± 0.00	73.38 ± 0.00	73.29 ± 0.00	73.27 ± 0.00	73.37 ± 0.12

Table 3 Chemical analysis of treated and control flour samples.

Analytical Parameters	Potassium bromate ($KBrO_3$)				
	0 (Control)	0.08 g/kg	0.16 g/kg	0.32 g/kg	Mean ± S.D.
Sugar (as maltose) mg/10g flour	195 ± 0.00	195 ± 0.00	195 ± 0.00	195 ± 0.00	195 ± 0.00
$KBrO_3$ (ppm)	nil	45	95	158	74.5 ± 67.85

Proximate composition of the baked products

The presence of bromate, irrespective of the concentration, had no significant effect on the proximate composition of the baked products (Table 4).

Sensory evaluation and acceptability studies

Analysis of variance of mean scores for loaf size, crust colour, crust texture and aroma of the bread baked from treated and control samples showed a significant difference at 5% level of probability. Preferences were shown for samples that contained 0.08 g/kg and 0.16 g/kg of potassium bromate.

Effect of storage temperature on estimation of consumer acceptability

It was observed that bread stored in the domestic freezer (–8^{o}C) retained all the physical quality attributes. Those stored in the refrigerator (5^{o}C) showed hard crust texture which broke easily and the crumb texture was slightly soft. The bread samples stored at ambient temperature (31^{o}C) compared favourably only in volume and crust colour with those stored at the other two temperatures (Table 5). The incorporation of bromate had no effect on these physical quality attributes (Table 5).

Table 4 Proximate composition of the baked products.

Analytical Parameters	Potassium bromate ($KBrO_3$)				
	0 (Control)	0.08 g/kg	0.16 g/kg	0.32 g/kg	Mean ± S.D.
Moisture	42.70	43.60	43.80	44.00	43.53 ± 0.57
Crude protein	10.10	10.10	10.00	10.00	10.05 ± 0.06
Fat	1.31	1.33	1.38	1.40	1.36 ± 0.04
Ash	1.55	1.60	1.60	1.60	1.59 ± 0.03
Carbohydrate (by difference)	44.34	43.37	43.22	43.00	43.46 ± 0.59

Table 5: Storage studies at various temperatures

Quality Attributes	Potassium bromate (g/kg)											
	Control			0.08			0.16			0.32		
	–8°C	5°C	31°C	–8°C	5°C	31°C	–8°C	5°C	31°C	–8°C	5°C	31°C
Volume/Size	N	N	N	N	N	N	N	N	N	N	N	N
Crust Colour	N	N	N	N	N	N	N	N	N	N	N	N
Crust Texture	H	HB	HB	H	HB	HB	H	HB	HB	H	HB	HB
Crumb Texture	VS	SS	HC	VS	SS	HC	VS	SS	HC	VS	SS	HC
Aroma	NBA	NBA	SR	NBA	NBA	SR	NBA	NBA	SR	NBA	NBA	SR

KEY: N = Normal; H = Hard; HB = Hard and Breaks; HC = Hard and Crumbles; SR = Sour and Repulsive; SS = Slightly Soft; VS = Very Soft; NBA = Normal Bread Aroma.

Discussion

The importance of wheat grains in the baking industry is well known. In the present study, the values obtained for the proximate composition of wheat were similar to those reported by other workers (Kent-Jones and Mitchel, 1982; Coultate, 1989; Ihekoronye and Ngoddy, 1985; Bennion, 1967 and Watson et al., 1979). the slight increase in the moisture content of the flour prepared from the grains could be attributed to the ability of the flour to trap air which contains some water droplets. The trend in the other values is in agreement with the findings of Jones et al. (1983). the addition of potassium bromate, however, made no significant changes to the proximate composition. Its presence is basically to improve the quality of the baked product.

The use of flour improvers like potassium bromate is very common in the baking industry. Himata et al. (1997) developed an analytical procedure to measure bromate residues in baked products. Other substances, especially antioxidants, have also been used. Park et al. (1997) studied the effect of baking and storage at room temperature on bread that was fortified with three antioxidants, namely fat-coated L-ascorbic acid (ASA), cold-water-dispersible (CWD) beta-carotene and CWD all-rac-alpha-tocopheryl acetate (ToAc).

Sensory evaluation and acceptability studies revealed that the presence of potassium bromate, especially at 0.8 g/kg and 0.16 g/kg improved the loaf size, crust colour, crust texture and the aroma of the bread. This could be due to the fact that the fortification at these levels improved the gluten structure of the dough so that a lot of carbon dioxide produced during fermentation could be retained thereby enhancing the size of the loaf produced.

De-Renzo (1975) found that the incorporation of potassium bromate at these concentrations in the wheat flour contributed immensely to the gas retaining ability of the dough.

The presence of potassium bromate did not affect temperature on storage. These observations were similar for both the control and the treated samples. The fact that the treated samples could show spoilage signs at room temperature like the control proved that it had no antimicrobial resistance resulting from the presence of bromate. The sour and repulsive aroma must be due to the effect of spoilage by microorganisms such as fungi which will thrive effectively on media containing sugar in an environment of high relative humidity. Edwards and Bamiro (1977) found that bread samples stored at ambient temperatures (31^{o}C) had sour and repulsive aroma which affected consumer acceptability in a negative manner. The change in the crumb and crust texture can be attributed to loss of moisture to the immediate environment. Storage at freezing temperature was most effective as it could control microbial deterioration and excessive water loss during storage. It should be noted, however, that such foods should be consumed immediately after thawing.

It can be concluded that the addition of potassium bromate as a flour enhancer has no positive contribution to the shelf life and nutritive value of the baked product. the positive effect on the loaf size can be obtained from using improved yeast strains for the fermentation of the dough. It will, therefore, not be wise to recommend the use of this chemical in break making, especially when emphasis is placed on the disuse of chemicals as additives in foods. The use of natural products as food enhancers should be encouraged.

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